Canadian Grain Commission
Commission canadienne des grains

ISSN 1498-9743

# Grain Research Laboratory Annual Harvest Report

## Quality of Western Canadian malting barley 2013

**Aaron L. MacLeod**
Chemist, Malting Barley Research

**Marta S. Izydorczyk**
Program Manager, Milling and Malting / Research on Barley and Other Grains

Grain Research Laboratory
Canadian Grain Commission
1404-303 Main Street
Winnipeg MB R3C 3G8
www.grainscanada.gc.ca

Canada

An electronic version of this publication as well as a French version is available online at www.grainscanada.gc.ca.

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Agriculture and Agri-Food Canada, 2013

# Table of contents


Summary ..... 5

Part 1- Growing and harvesting conditions in 2013 ..... 6

Part 2 - Barley Production ..... 8

Part 3 - GRL Annual Harvest Survey ..... 11

3.1 GRL sampling and survey methodology ..... 11

3.2 Quality of barley selected for malting in 2013: general trends and annual statistics ..... 11

3.3 GRL malting conditions and methodologies ..... 15

3.4 Malting quality in 2013 - Highlights ..... 15

AC Metcalfe ..... 16

CDC Copeland ..... 18

CDC Meredith ..... 20

Newdale ..... 22

Bentley ..... 24

CDC Kindersley ..... 26

Legacy ..... 28

Celebration ..... 30

Appendix I - Methods ..... 32

Acknowledgments ..... 34


**Tables**


Table 2.1 Comparison of barley production in Western Canada for 2013 and 2012 with the ten year average production ..... 8

Table 2.2 Distribution of two rowed malting barley cultivars as percentage of acreage seeded to malting barley in Western Canada ..... 9

Table 2.3 Distribution of six rowed malting barley cultivars as percentage of acreage seeded to malting barley in Western Canada ..... 10

Table 2.4 Malting barley cultivars recommended for production in Western Canada in 2014-2015 ..... 10

Table 3.4 Malting conditions used with Phoenix Micromalting System in 2013 ..... 15

Table 3.5 Harvest survey results for 2013 composite samples of AC Metcalfe ..... 17

Table 3.6 Harvest survey results for 2013 composite samples of CDC Copeland ..... 19

Table 3.7 Harvest survey results for 2013 composite samples of CDC Meredith ..... 21

Table 3.8 Harvest survey results for 2013 composite samples of Newdale ..... 23

Table 3.9 Harvest survey results for 2013 composite samples of Bentley ..... 25

Table 3.10 Harvest survey results for 2013 composite samples of CDC Kindersley ..... 27

Table 3.11 Harvest survey results for 2013 composite samples of Legacy ..... 29

Table 3.12 Harvest survey results for 2013 composite samples of Celebration ..... 31

## Figures

Figure 1.1 Mean temperature difference from normal for April 2013 ..... 7

Figure 1.2 Percent of monthly average precipitation received in September 2013 ..... 7

Figure 2.1 Annual production and area seeded to malting barley for 2004-2013 ..... 8

Figure 2.2 Distribution of barley classes as percentage of total area seeded to barley in three Western Canada provinces in 2013 ..... 9

Figure 3.1 Average protein content in barley selected for malting from 2004-2013 ..... 11

Figure 3.2 Average kernel weight of barley selected for malting from 2004-2013 ..... 12

Figure 3.3 Average plumpness of malting barley varieties selected for malting in 2013 ..... 12

Figure 3.4 Average kernel diameter of barley varieties selected for malting in 2013 ..... 13

Figure 3.5 Average hardness of barley varieties selected for malting in 2013 ..... 13

Figure 3.6 RVA results for barley selected for malting in three Western Canada provinces in 2013 ..... 14

# Summary

Total barley production in Western Canada in 2013 was estimated at 8,894,000 tonnes, representing a substantial increase of about 18% compared to 2012. The increase in production was associated with a record yield of 68.2 bushels per acre. Acreage seeded to barley in 2013 decreased by 5% from 2012 (Statistics Canada).

The growing season was characterized by normal amounts of rainfall in June and early July, followed by cooler and drier than normal conditions during the reproductive stage in late July and early August. Warm and dry harvest conditions were prevalent in the Peace River region and through northern Alberta and central Saskatchewan. Some areas in southern Alberta received higher than average amount of precipitation in September.

The 2013 barley harvest survey, conducted by the Grain Research Laboratory, was based on 76 composites of individual varieties representing 925,900 tonnes of barley selected in Western Canada for malting by the grain handling and malting companies.

Malting barley selected in 2013 was above average quality with protein levels lower than the 10-year average; thousand kernel weights, plumpness and kernel size were substantially higher than average values. This year's harvest resulted in malts with excellent quality. High plumpness, combined with low protein, resulted in very high levels of extract. Well modified malts were readily obtained, resulting in low wort β-glucan and good levels of soluble protein and free amino nitrogen. Enzyme levels were close to the long term average.

# Part 1- Growing and harvesting conditions in 2013

## Seeding

The early spring season was very cool resulting in delayed planting across the Prairies, with minimal seeding commencing before May 1st (Figure 1.1). Record amounts of winter snowfall in south and central Saskatchewan helped to replenish low soil moisture levels. Although some heavy rainfall in southern regions caused delays and reductions in acres, dry conditions in the majority of areas allowed seeding to progress rapidly, with the majority of the crop in the ground by June 1st.

## Growing Season

Most growing areas received normal amounts of rainfall in June and early July which aided early crop development. Cooler and dryer conditions during the reproductive stage in late July and early August allowed the crop to mature with minimal stress and a long grain filling period resulting in lower protein levels and larger, heavier kernels.

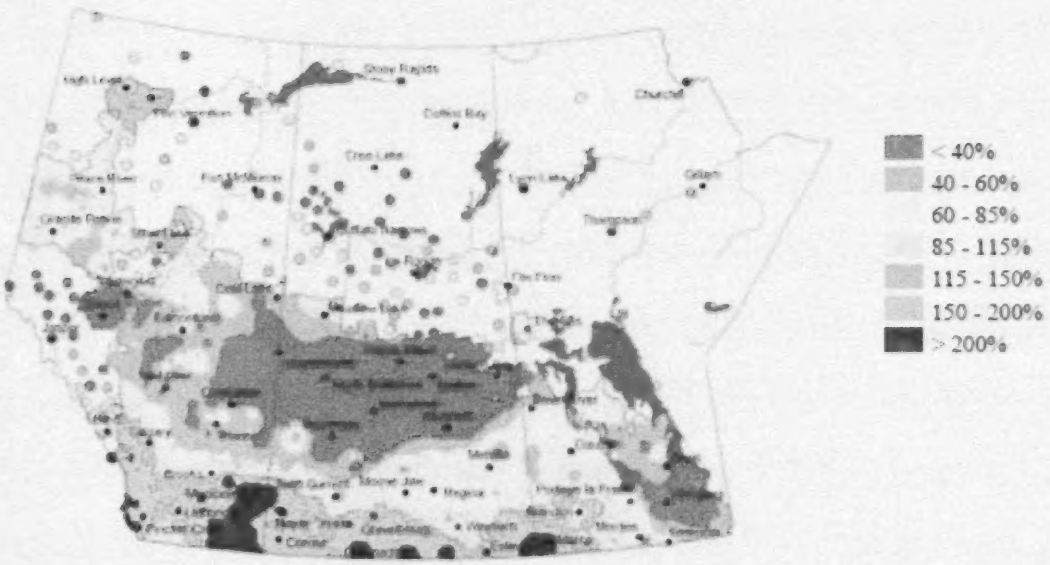
## Harvest

Warm weather in late August and September allowed crops to mature before the first fall frost. The warm dry conditions also advanced crop maturity, and allowed harvest to progress rapidly. Dry conditions were prevalent in the Peace region and through northern Alberta and central Saskatchewan, whereas wet conditions in southern regions resulted in some damage due to sprouting later in the harvest period (Figure 1.2). Harvest progress, although later than normal, proceeded rapidly with most crop in the bin by mid October.

**Figure 1.1 Mean temperature difference from normal for April 2013**

© 2013 Agriculture and Agri-Food Canada

**Figure 1.2 Percent of monthly average precipitation received in September 2013**




© 2013 Agriculture and Agri-Food Canada

# Part 2 - Barley Production

Total barley production in Western Canada in 2013 was estimated at 8,894,000 tonnes, representing a substantial increase of about 18% compared to 2012 (Table 2.1). In each province, the increased barley production was associated with a record yield of 68.2 bushels per acre compared to 54.1 bushels per acre in 2012 (Statistics Canada). Acreage seeded to barley in 2013 decreased by 5% from 2012, continuing a long term downward trend due to competition for acres from other crops (Figure 2.1).

**Table 2.1 Comparison of barley production in Western Canada for 2013 and 2012 with the ten year average production[1]**

| | Seeded area | | | Production | | |
|---|---|---|---|---|---|---|
| | 2013 | 2012 | 2004-2013 average | 2013 | 2012 | 2004-2013 average |
| | thousand hectares | | | thousand tonnes | | |
| Manitoba | 190 | 219 | 290 | 686 | 618 | 843 |
| Saskatchewan | 1,052 | 1,062 | 1,392 | 3,331 | 2,351 | 3,635 |
| Alberta[2] | 1,465 | 1,554 | 1,689 | 4,877 | 4,519 | 4,878 |
| **Total** | **2,707** | **2,835** | **3,372** | **8,894** | **7,488** | **9,356** |

[1] Statistics Canada, Table 001-0010 *Estimated areas and production of principle field crops.* http://www5.statcan.gc.ca/cansim (Accessed October 10th 2013)

[2] Alberta figures include small amounts grown in British Columbia

**Figure 2.1 Annual production and area seeded to malting barley for 2004-2013**

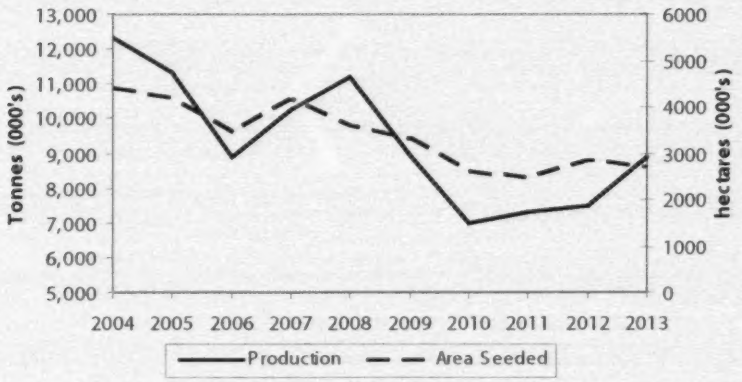
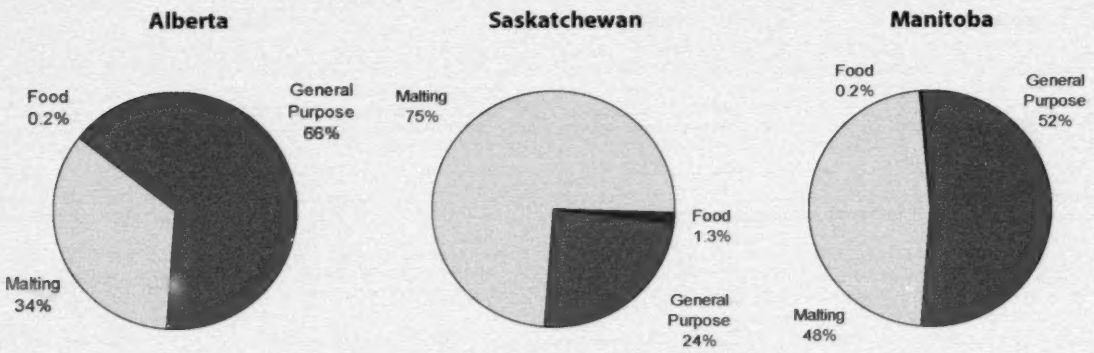


**Figure 2.2 Distribution of barley classes as percentage of total area seeded to barley in three Western Canada provinces[1] in 2013**




Barley is a multi-purpose crop grown in a widespread area across the Canadian Prairies. Although only approximately 25% of the crop is selected annually for malting purposes, the majority ending up as feed or forage, over half of the acreage is seeded to malting barley varieties (Figure 2.2). The predominate type of barley grown in Western Canada is two-rowed malting, with AC Metcalfe remaining the dominant variety in 2013, occupying 36% of total acres seeded to malting barley (Table 2.2). However, Metcalfe is slowly being replaced by a portfolio of newer two-rowed cultivars. This trend is expected to continue as newer malting barley cultivars become better accepted in the marketplace. Six-rowed malting barley, traditionally produced in the eastern Prairies and exported to the United States, continues to decline in acres, now representing only a small fraction of total barley production (Table 2.3).

**Table 2.2 Distribution of two-rowed malting barley cultivars as percentage of acreage seeded to malting barley in Western Canada[1]**

| | Alberta | Saskatchewan | Manitoba | Prairies | |
|---|---|---|---|---|---|
| | 2013 | 2013 | 2013 | 2013 | 2012 |
| | % | % | % | % | % |
| AC Metcalfe | 36.0 | 39.5 | 10.7 | 36.3 | 44.3 |
| CDC Copeland | 31.2 | 24.5 | 6.6 | 25.8 | 27.4 |
| CDC Meredith | 17.9 | 12.0 | 4.8 | 13.7 | 6.6 |
| Newdale | 6.2 | 6.0 | 24.2 | 7.2 | 6.3 |
| Major | 1.6 | 3.1 | 1.8 | 2.5 | 0.6 |
| Bentley | 3.1 | 0.6 | 5.7 | 1.8 | 1.2 |
| CDC Polarstar | 0.2 | 1.7 | 0.0 | 1.0 | 1.4 |
| CDC Kindersley | 1.0 | 0.3 | 0.0 | 0.5 | 0.3 |
| Merit 57 | 0.8 | 0.0 | 0.0 | 0.3 | 0.2 |
| CDC Kendall | 0.2 | 0.3 | 0.0 | 0.2 | 0.6 |
| Other | 0.6 | 0.2 | 0.7 | 0.1 | 0.2 |

[1]Data Source: Sask Crop Insurance, Alberta Ag Financial Services Corp, & Manitoba Management Plus Program

**Table 2.3 Distribution of six-rowed malting barley cultivars as percentage of acreage seeded to malting barley in Western Canada[1]**

| | Manitoba | Saskatchewan | Alberta | Prairies | |
|---|---|---|---|---|---|
| | 2013 | 2013 | 2013 | 2013 | 2012 |
| | % | % | % | % | % |
| Legacy | 0.3 | 9.8 | 3.6 | 5.9 | 6.3 |
| Celebration | 0.0 | 0.6 | 23.1 | 1.9 | 1.6 |
| Tradition | 0.0 | 1.2 | 12.3 | 1.5 | 1.6 |
| Stellar ND | 0.0 | 0.0 | 5.8 | 0.4 | 0.4 |
| Robust | 0.2 | 0.1 | 3.0 | 0.3 | 0.4 |
| CDC Yorkton | 0.4 | 0.1 | 1.5 | 0.3 | 0.1 |
| Lacey | 0.2 | 0.0 | 1.7 | 0.2 | 0.2 |
| Other | 0.0 | 0.1 | 0.3 | 0.2 | 0.2 |

[1]Data Source: Sask Crop Insurance, Alberta Ag Financial Services Corp, & Manitoba Management Plus Program

The Canadian Malting Barley Technical Center (CMBTC), in collaboration with its member organizations and other barley industry groups, produces an annual Recommended Malting Barley Varieties List which is intended as a guide to assist producers in the selection of varieties for seeding in the coming year (Table 2.4).

**Table 2.4 Malting barley cultivars recommended for production in Western Canada in 2014-2015**

**Recommended two-rowed malting varieties**

| Variety | Domestic | Export |
|---|---|---|
| AC Metcalfe | Established | Established |
| CDC Copeland | Established | Established |
| CDC Meredith | Established | Limited |
| CDC Polarstar | Established | Established |

**The four varieties above will represent 80 to 85% of the anticipated selections.**

| Variety | Commercialization Status |
|---|---|
| Newdale | Established |
| Major | Increasing |
| Bentley | Increasing |
| Merit 57 | Increasing |
| CDC Kindersley | Increasing |

**Recommended six-rowed barley varieties**

| Variety | Domestic | Export |
|---|---|---|
| Legacy | Established | Established |
| Stellar-ND | Established | Established |
| Tradition | Established | Established |
| Celebration | Limited | Limited |

Source: Canadian Malting Barley Technical Centre

# Part 3 - GRL Annual Harvest Survey

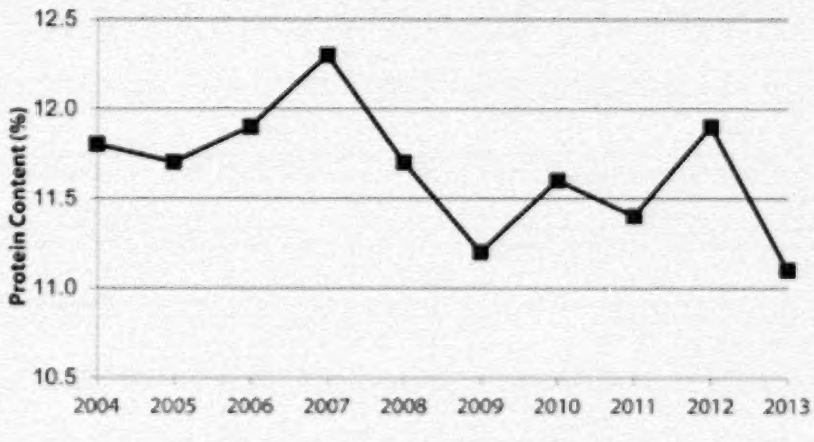
## 3.1 GRL sampling and survey methodology

The Canadian Grain Commission conducts an annual survey to determine the quality of malting barley grown in the three Prairie Provinces. The data generated for this report were based on the analysis of representative varietal composite samples selected for malting purposes. The 2013 malting barley survey was based on 76 varietal composites representing 925,900 tonnes of barley which had been selected for domestic malt processing or for export as malting barley by Cargill Inc., Canada Malting Co. Ltd., Parrish and Heimbecker Co. Ltd., Malteurop, Rahr Malting Co. Ltd., Richardson International, and Viterra Inc. The tonnage included in this survey represent only a portion of the total volume of malting barley selected in Western Canada through the end of October, and does not necessarily reflect the actual amounts selected. Samples were received from the beginning of harvest until the 26th of October.

## 3.2 Quality of barley selected for malting in 2013: general trends and annual statistics

Malting barley selected in 2013 was of above average quality. Protein levels were the lowest seen over the last 10 years (Figure 3.1).

**Figure 3.1 Average protein content in barley selected for malting from 2004-2013**



Thousand kernel weights (Fig. 3.2) and kernel plumpness (Fig. 3.3) were above long term averages and correlated positively with large diameters of barley kernels (Fig. 3.4). Large kernels with low protein content are generally associated with increased levels of starch and therefore greater potential for high extract. However, excessively large kernels could have an impact on malt quality, particularly on the rate of water hydration and modification during malting.

**Figure 3.2 Average 1000 kernel weight of barley selected for malting from 2004-2013**

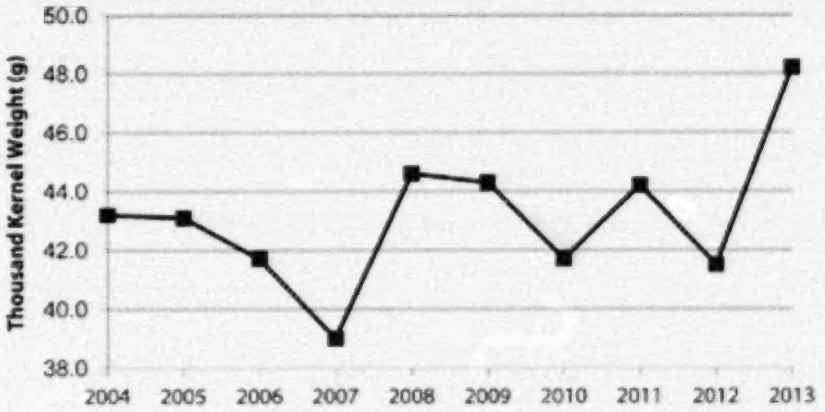



**Figure 3.3 Average plumpness of barley selected for malting from 2004-2013**

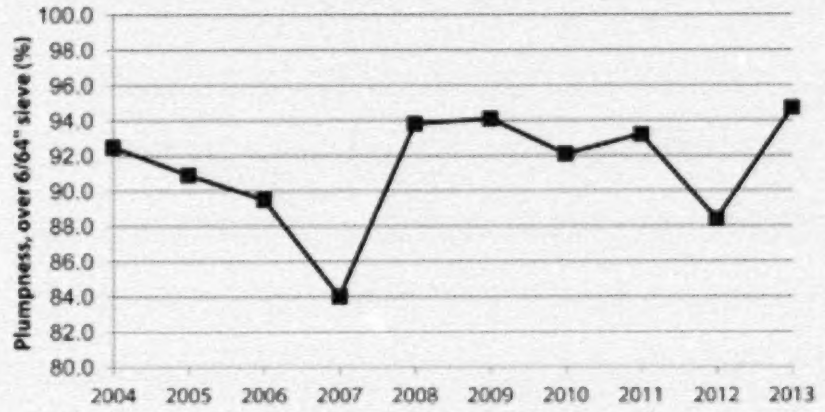
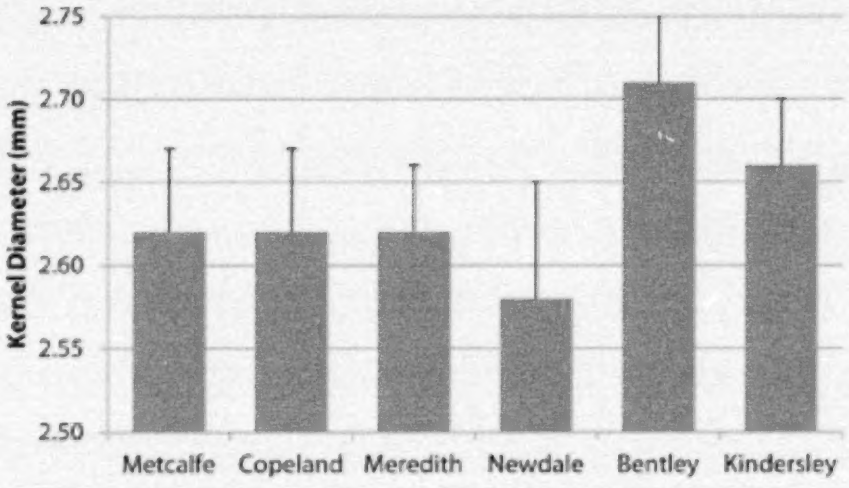
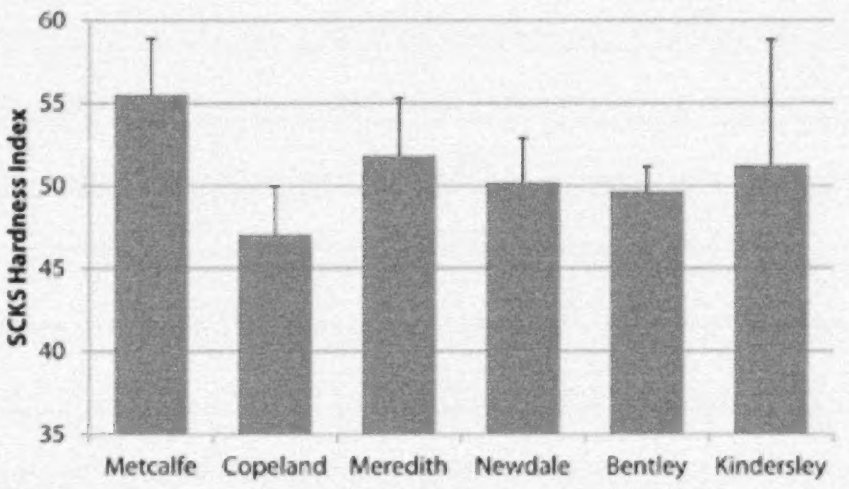


**Figure 3.4 Average kernel diameter of barley varieties selected for malting in 2013**



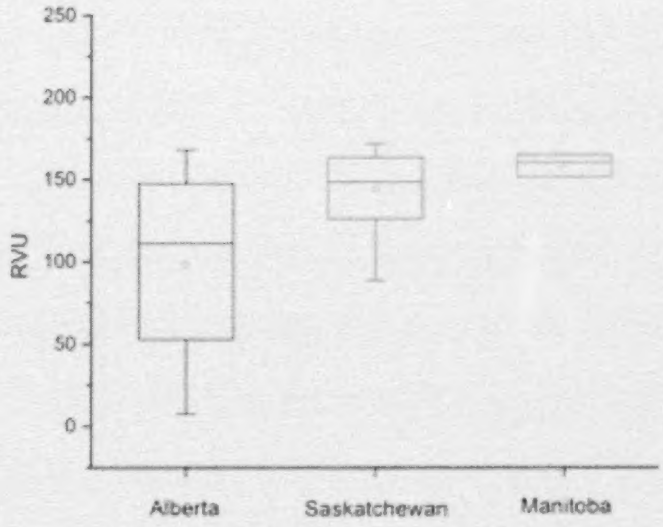

Another unusual characteristic of barley grain this year was relatively low grain hardness (Fig. 3.5). Grain hardness is not routinely measured when evaluating barley grain quality. High grain protein and β-glucan levels are usually positively correlated with high grain hardness indices, whereas malt extract and endosperm modification are usually negatively correlated with grain hardness. This year's barley was softer, which can facilitate water uptake during steeping.

**Figure 3.5 Average hardness index of barley varieties selected for malting in 2013**



Rapid visco analysis (RVA) is used by barley selectors to identify sound, moderately and strongly pre-germinated barley, and manage their supply accordingly. This year's RVA results have reflected generally favorable harvest conditions with only localized areas experiencing above average precipitation. Figure 3.6 shows the distribution of RVA data by province. Among the total of 76 barley samples analyzed this year, 52% of the samples showed very high RVA values, ranging from 120 to 170 RVU (rapid visco units), and indicating a high degree of soundness and a high probability of retaining germination energy during a long-term storage. Nearly a quarter (23%) of the samples exhibited moderate pre-germination (50-110 RVU) and, therefore, good potential for storability provided proper cool and dry storage conditions. Slightly more than a quarter (26%) of the samples showed the RVA values lower than 50 RVU, primarily coming from Alberta, stressing the need for identification of barley that should be malted promptly unless stored in cold and dry conditions for a short period.

**Figure 3.6 RVA results for barley selected for malting in three Western Canada provinces in 2013**




Risk of germination loss in storage is low for RVA >120; intermediate for 50 < RVA < 120; high for RVA < 50. The box shows the range of RVA values in the middle 50% of the analyzed samples; the horizontal line and the dot inside the box indicate the median and mean, respectively. The short horizontal lines outside of the box mark the minimum and maximum values.

## 3.3 GRL malting conditions and methodologies

Favourable growing conditions across most of the Prairies resulted in barley with lower protein levels and larger, heavier kernels. Excellent germination energies, with little evidence of water sensitivity supported the use of a standard micro-malting schedule with two wet steep cycles (Table 3.4), as was used in 2012. The use of the same schedule facilitates year-to-year comparisons. All analytical methods used in this survey to assess the barley, malt an wort quality are listed in the Appendix I.

**Table 3.4 Malting conditions used with Phoenix Micromalting System in 2013**

| | |
|---|---|
| Steeping | 10 h wet steep, 18 h air rest, 8 h wet steep, 12 h air rest @ 13°C |
| Germination | 96 h @ 15°C |
| Kilning | 12h @ 60°C, 6h@ 65°C, 2h @ 75°C, 4h @ 85°C |

## 3.4 Malting quality in 2013 - Highlights

This year's harvest resulted in malts with excellent quality:

- High plumpness combined with low protein resulted in **very high levels of malt extract**. Generally, the malt extract for the most common malting barley cultivars was higher by about 1.2% compared to the 5-year average values.
- Well modified malts were readily obtained resulting in **low wort β-glucan** and **good levels of soluble protein** and **free amino nitrogen**. Enzyme levels (diastatic power and α-amylase) in malts were adequate and close to the long term average.
- Despite their large size, **kernels took up water easily**, and **modified rapidly**. Good water uptake and adequate steep-out moisture during malting could be associated with somewhat softer endosperm as indicated by relatively low hardness index values in barley.
- Slightly higher than average malt losses, as indicated by lower than normal malt yields, suggest that the malts produced in this study were somewhat over-modified.

# AC Metcalfe

AC Metcalfe continues to be the dominant malting barley variety grown in Western Canada. With high levels of extract and diastatic enzymes, its reputation for excellent brewing performance generates strong demand from both domestic and export markets.

**Figure 1. Percentage of the total malting barley acres in Western Canada seeded to AC Metcalfe in 2013 and 2012**

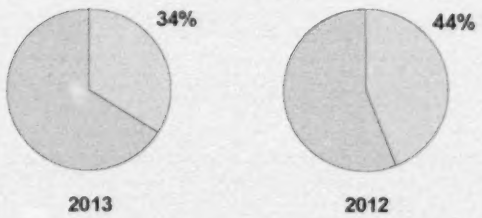



**Figure 2. Average protein content in AC Metcalfe selected for malting from 2009-2013**

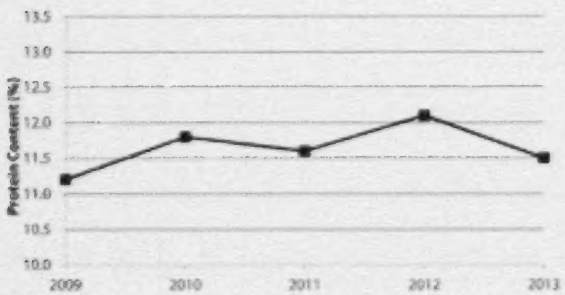



**Figure 3. Average kernel weight of AC Metcalfe selected for malting from 2009-2013**

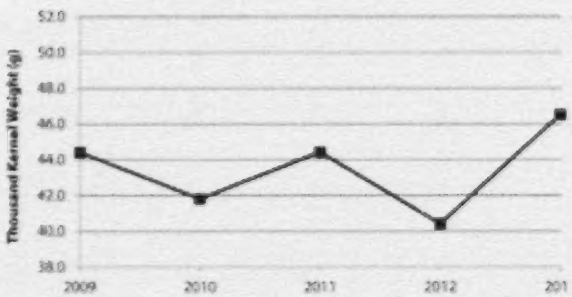



**Figure 4. Comparison of average levels of extract by variety in 2013**

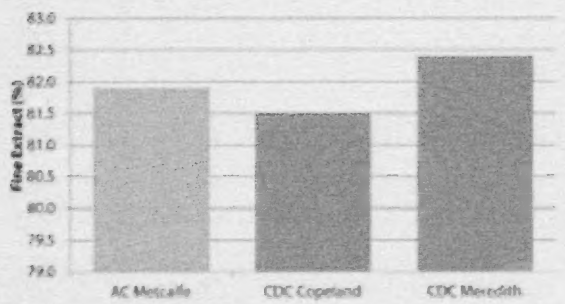
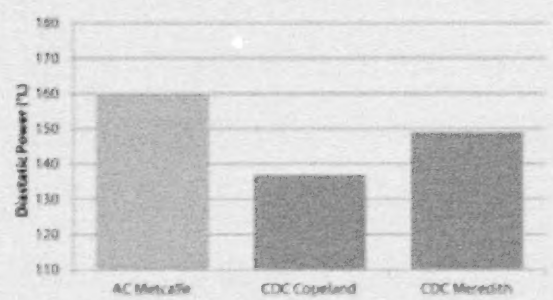



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**



## Table 3.5 Harvest survey results for 2013 composite samples of AC Metcalfe

| Origin of selected samples | Manitoba | Saskatchewan | | Alberta | | All Prairie Provinces[1] | | |
|---|---|---|---|---|---|---|---|---|
| Crop year | 2013 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 5-year avg. |
| Thousands of tonnes[2] | 7 | 175 | 74 | 187 | 108 | 369 | 236 | 333 |
| **Barley** | | | | | | | | |
| Physical characteristics | | | | | | | | |
| Test Weight, kg/hL | 70.9 | 68.8 | 64.9 | 69.5 | 66.5 | 69.2 | 65.7 | 67.2 |
| 1000 kernel weight, g | 48.1 | 46.2 | 39.9 | 46.7 | 40.9 | 46.5 | 40.4 | 43.5 |
| Heavy grade, over 6/64" sieve, % | 94.2 | 93.6 | 87.4 | 93.8 | 88.1 | 93.7 | 87.8 | 92.0 |
| Intermed grade, over 5/64"sieve, % | 4.6 | 4.9 | 9.6 | 4.8 | 8.3 | 4.8 | 8.5 | 6.0 |
| Chemical analysis | | | | | | | | |
| Moisture, %[3] | 11.8 | 11.5 | 11.0 | 11.4 | 11.2 | 11.5 | 10.7 | 11.5 |
| Protein, % | 11.4 | 11.5 | 12.3 | 11.5 | 11.9 | 11.5 | 12.1 | 11.6 |
| Germination, 4 ml (3 day), % | 94 | 99 | 99 | 98 | 99 | 98 | 99 | 98 |
| Germination, 8 ml (3 day), % | 89 | 90 | 87 | 89 | 87 | 90 | 88 | 88 |
| **Malt** | | | | | | | | |
| Physical characteristics | | | | | | | | |
| Yield, % | 90.8 | 90.1 | 90.9 | 90.0 | 91.8 | 90.1 | 91.3 | 92.4 |
| Steep-out moisture, % | 44.6 | 44.8 | 44.7 | 44.9 | 44.7 | 44.8 | 44.8 | 45.6 |
| Friability, % | 75.3 | 77.8 | 68.6 | 77.4 | 72.5 | 77.6 | 72.0 | 70.9 |
| Chemical analysis | | | | | | | | |
| Moisture, % | 4.8 | 5.1 | 5.4 | 5.1 | 5.2 | 5.1 | 5.2 | 5.2 |
| **Wort** | | | | | | | | |
| Fine grind extract, % | 82.6 | 81.8 | 80.0 | 81.9 | 80.1 | 81.9 | 80.1 | 80.6 |
| Coarse grind extract, % | 80.4 | 80.6 | 79.6 | 80.8 | 79.4 | 80.7 | 79.5 | 79.9 |
| F/C difference, % | 1.2 | 0.9 | 0.4 | 0.7 | 0.7 | 0.8 | 0.5 | 0.6 |
| ß-Glucan, ppm | 52 | 53 | 57 | 48 | 62 | 50 | 56 | 77 |
| Viscosity, cps | 1.45 | 1.44 | 1.41 | 1.44 | 1.41 | 1.44 | 1.41 | 1.43 |
| Soluble protein, % | 4.45 | 4.71 | 5.06 | 4.76 | 4.78 | 4.73 | 4.93 | 4.73 |
| Ratio S/T, % | 39.0 | 41.2 | 40.6 | 41.4 | 39.7 | 41.3 | 40.3 | 40.1 |
| FAN, mg/L | 213 | 211 | 222 | 212 | 202 | 212 | 211 | 195 |
| Colour, ASBC units | 2.07 | 2.00 | 2.29 | 2.00 | 1.94 | 2.00 | 2.14 | 1.96 |
| Diastatic power, °L | 150 | 157 | 177 | 163 | 169 | 160 | 168 | 164 |
| α-amylase, D.U. | 72.6 | 73.6 | 69.7 | 74.4 | 66.9 | 74.0 | 68.2 | 68.7 |

[1] Weighted average values

[2] Does not necessarily represent amounts commercially selected

[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# CDC Copeland

CDC Copeland is the second major two-rowed malting variety grown on the Prairies. Its excellent brewing characteristics combined with lower protein and enzyme levels, provides an excellent balance within the portfolio of malting barley varieties.

**Figure 1. Percentage of the total malting barley acres in Western Canada seeded to CDC Copeland in 2012 and 2013**

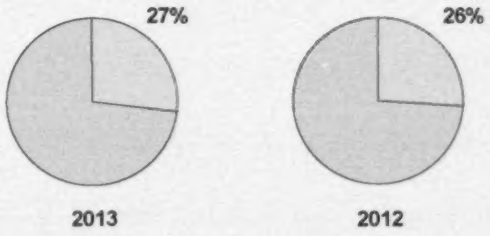



**Figure 2. Average protein content in CDC Copeland selected for malting from 2009-2013**

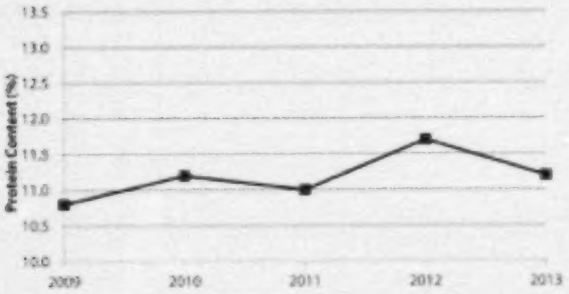



**Figure 3. Average kernel weight of CDC Copeland selected for malting from 2009-2013**

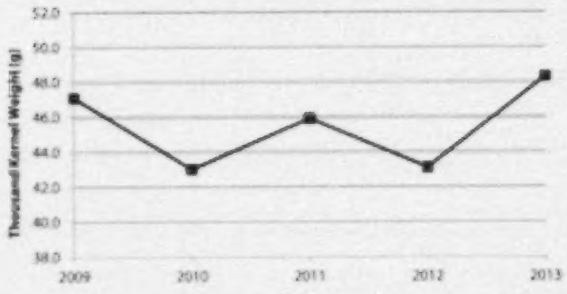



**Figure 4. Comparison of average levels of extract by variety in 2013**

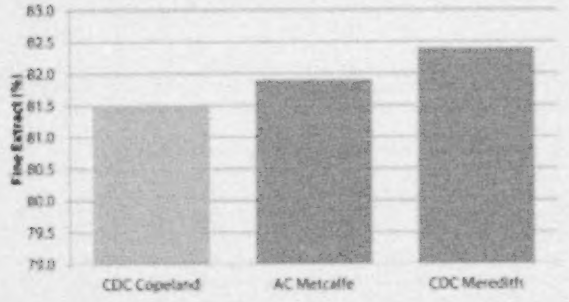
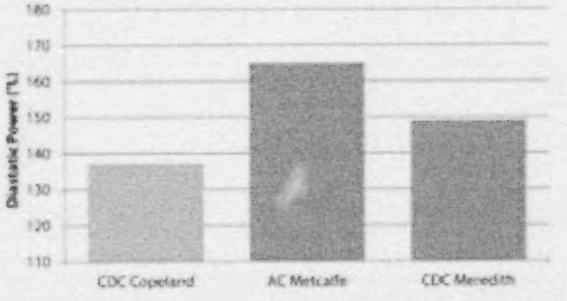



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**



## Table 3.6 Harvest survey results for 2013 composite samples of CDC Copeland

| Origin of selected samples | Manitoba | Saskatchewan | | Alberta | | All Prairie Provinces[1] | | |
|---|---|---|---|---|---|---|---|---|
| Crop year | **2013** | **2013** | 2012 | **2013** | 2012 | **2013** | 2012 | 5-year avg. |
| Thousands of tonnes[2] | **8** | **127** | 62 | **186** | 117 | **321** | 233 | 202 |
| **Barley** | | | | | | | | |
| Physical characteristics | | | | | | | | |
| Test Weight, kg/hL | **69.2** | **67.8** | 63.7 | **67.3** | 65.2 | **67.6** | 64.7 | 66.3 |
| 1000 kernel weight, g | **48.9** | **48.7** | 42.2 | **48.0** | 43.7 | **48.3** | 43.1 | 45.5 |
| Heavy grade, over 6/64" sieve, % | **94.6** | **94.3** | 87.7 | **93.9** | 89.3 | **94.1** | 88.6 | 92.7 |
| Intermed grade, over 5/64"sieve, % | **4.3** | **4.4** | 9.4 | **4.7** | 8.3 | **4.6** | 8.4 | 5.6 |
| Chemical analysis | | | | | | | | |
| Moisture, %[3] | **12.1** | **11.6** | 11.1 | **11.7** | 11.7 | **11.7** | 11.0 | 11.7 |
| Protein, % | **11.1** | **11.1** | 11.8 | **11.2** | 11.7 | **11.2** | 11.7 | 11.2 |
| Germination, 4 ml (3 day) % | **96** | **98** | 98 | **99** | 99 | **98** | 98 | 98 |
| Germination, 8 ml (3 day) % | **94** | **95** | 93 | **94** | 93 | **94** | 93 | 92 |
| **Malt** | | | | | | | | |
| Physical characteristics | | | | | | | | |
| Yield, % | **91.3** | **91.1** | 91.2 | **90.7** | 92.3 | **90.9** | 91.9 | 92.7 |
| Steep-out moisture, % | **44.3** | **44.0** | 45.3 | **44.2** | 44.2 | **44.1** | 44.5 | 45.3 |
| Friability, % | **83.6** | **83.6** | 77.9 | **82.7** | 77.2 | **83.1** | 77.8 | 78.9 |
| Chemical analysis | | | | | | | | |
| Moisture, % | **4.9** | **4.9** | 5.1 | **5.0** | 5.0 | **4.9** | 5.1 | 5.1 |
| **Wort** | | | | | | | | |
| Fine grind extract, % | **82.3** | **81.7** | 79.8 | **81.4** | 79.8 | **81.5** | 79.9 | 80.4 |
| Coarse grind extract, % | **80.2** | **80.2** | 79.2 | **80.2** | 79.0 | **80.2** | 79.2 | 79.6 |
| F/C difference, % | **1.1** | **0.9** | 0.6 | **0.8** | 0.9 | **0.9** | 0.8 | 0.7 |
| ß-Glucan, ppm | **55** | **49** | 46 | **56** | 81 | **53** | 69 | 77 |
| Viscosity, cps | **1.45** | **1.43** | 1.40 | **1.44** | 1.42 | **1.44** | 1.41 | 1.43 |
| Soluble protein, % | **4.58** | **4.64** | 5.45 | **4.62** | 4.67 | **4.63** | 4.96 | 4.72 |
| Ratio S/T, % | **41.3** | **41.8** | 43.9 | **41.3** | 39.7 | **41.5** | 41.0 | 41.4 |
| FAN, mg/L | **212** | **202** | 236 | **196** | 192 | **199** | 207 | 187 |
| Colour, ASBC units | **2.16** | **2.10** | 2.84 | **1.95** | 1.98 | **2.01** | 2.26 | 2.04 |
| Diastatic power, °L | **144** | **135** | 154 | **138** | 145 | **137** | 146 | 139 |
| α-amylase, D.U. | **54.0** | **55.3** | 51.7 | **54.1** | 49.2 | **54.6** | 50.2 | 51.8 |

[1] Weighted average values
[2] Does not necessarily represent amounts commercially selected
[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# CDC Meredith

Appearing in this report for the third year, amounts of CDC Meredith barley being grown and selected continued to increase in 2012. With its good agronomics and disease resistance, CDC Meredith has the potential to produce superior yields making it an attractive choice for producers. Good malting characteristics such as consistently lower protein, higher extracts and moderate levels of enzymes translate into good overall brewing potential.

**Figure 1. Percentage of the total malting barley acres in Western Canada seeded to CDC Meredith in 2012 and 2013**

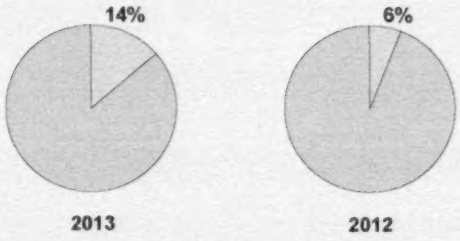



**Figure 2. Average protein content in CDC Meredith selected for malting from 2009-2013**

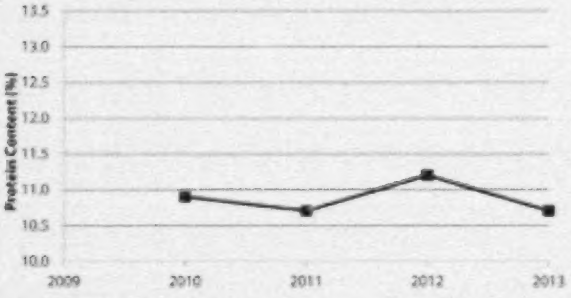



**Figure 3. Average kernel weight of CDC Meredith selected for malting from 2009-2013**

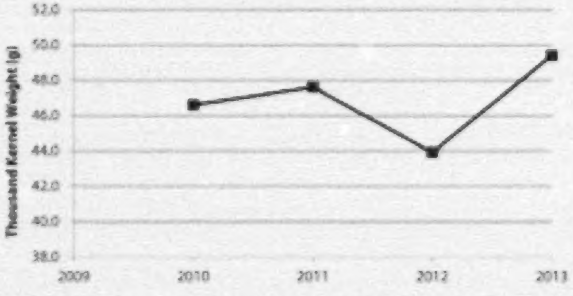



**Figure 4. Comparison of average levels of extract by variety in 2013**

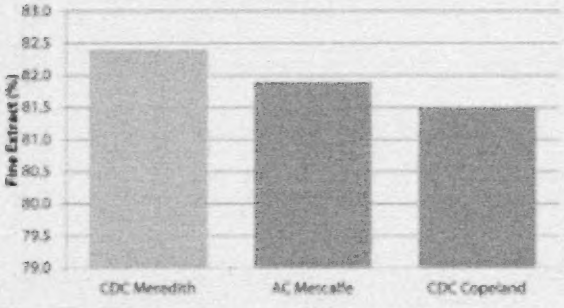
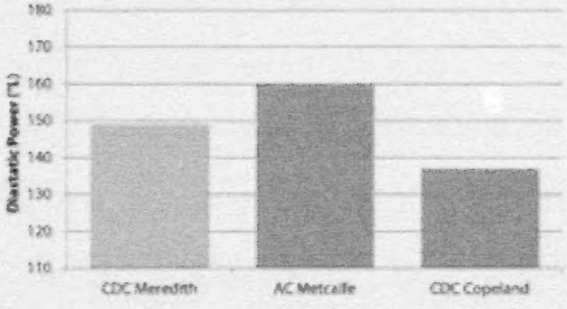



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**



## Table 3.7 Harvest survey results for 2013 composite samples of CDC Meredith

| | Saskatchewan | | Alberta | | All Prairie Provinces | | |
|---|---|---|---|---|---|---|---|
| Crop year | **2013** | 2012 | **2013** | 2012 | **2013** | 2012 | 3-year avg. |
| Thousands of tonnes | **60** | 4 | **105** | 38 | **165** | 43 | 75 |
| **Barley** | | | | | | | |
| Physical characteristics | | | | | | | |
| Test Weight, kg/hL | **67.7** | 63.0 | **67.3** | 64.8 | **67.4** | 64.5 | 66.3 |
| 1000 kernel weight, g | **50.7** | 41.1 | **48.7** | 44.3 | **49.4** | 43.9 | 46.9 |
| Heavy grade, over 6/64" sieve, % | **95.9** | 88.8 | **94.9** | 92.0 | **95.3** | 91.6 | 94.5 |
| Intermed grade, over 5/64"sieve, % | **3.0** | 9.0 | **3.7** | 5.8 | **3.4** | 6.2 | 4.1 |
| Chemical analysis | | | | | | | |
| Moisture, %[3] | **11.4** | 12.8 | **11.8** | 11.9 | **11.7** | 12.0 | 12.5 |
| Protein, % | **10.6** | 12.0 | **10.8** | 11.0 | **10.7** | 11.2 | 10.9 |
| Germination, 4 ml (3 day), % | **99** | 99 | **98** | 99 | **98** | 99 | 98 |
| Germination, 8 ml (3 day), % | **94** | 91 | **92** | 91 | **93** | 91 | 89 |
| **Malt** | | | | | | | |
| Physical characteristics | | | | | | | |
| Yield, % | **89.5** | 92.2 | **89.4** | 91.1 | **89.4** | 91.2 | 91.4 |
| Steep-out moisture, % | **45.3** | 45.6 | **45.5** | 45.5 | **45.5** | 45.5 | 46.5 |
| Friability, % | **85.4** | 81.7 | **84.7** | 84.5 | **85.0** | 84.1 | 81.1 |
| Chemical analysis | | | | | | | |
| Moisture, % | **4.8** | 4.5 | **4.9** | 5.1 | **4.9** | 5.0 | 5.1 |
| **Wort** | | | | | | | |
| Fine grind extract, % | **82.5** | 79.8 | **82.3** | 80.7 | **82.4** | 80.6 | 81.3 |
| Coarse grind extract, % | **81.1** | 78.9 | **81.3** | 79.6 | **81.2** | 79.5 | 80.4 |
| F/C difference, % | **0.8** | 0.9 | **0.7** | 1.1 | **0.8** | 1.1 | 0.8 |
| ß-Glucan, ppm | **65** | 126 | **54** | 70 | **58** | 76 | 94 |
| Viscosity, cps | **1.43** | 1.41 | **1.43** | 1.40 | **1.43** | 1.40 | 1.42 |
| Soluble protein, % | **4.76** | 5.34 | **4.74** | 4.80 | **4.75** | 4.87 | 4.80 |
| Ratio S/T, % | **45.1** | 42.6 | **44.1** | 43.6 | **44.5** | 43.5 | 43.9 |
| FAN, mg/L | **222** | 208 | **214** | 200 | **217** | 201 | 200 |
| Colour, ASBC units | **2.45** | 2.63 | **2.30** | 2.28 | **2.35** | 2.33 | 2.33 |
| Diastatic power, °L | **140** | 150 | **152** | 158 | **149** | 158 | 154 |
| α-amylase, D.U. | **63.6** | 58.3 | **64.3** | 57.5 | **64.0** | 57.7 | 59.0 |

[1] Weighted average values
[2] Does not necessarily represent amounts commercially selected
[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# Newdale

Newdale continues to represent a small, but consistent, share of barley selected each year. With good friability, and low levels of β-glucan, it performs well in the brewhouse. Its moderate levels of enzymes, soluble protein and FAN make Newdale well suited for all-malt brewing.

**Figure 1. Percentage of the total malting barley acres in Western Canada seeded to Newdale in 2012 and 2013**

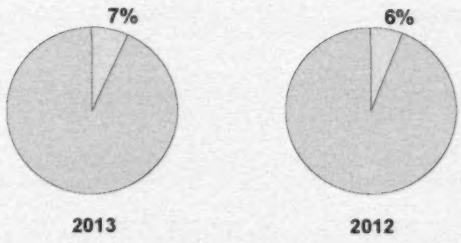



**Figure 2. Average protein content in Newdale selected for malting from 2009-2013**

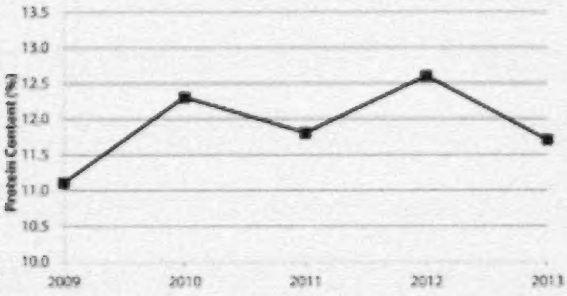



**Figure 3. Average kernel weight in Newdale selected for malting from 2009-2013**

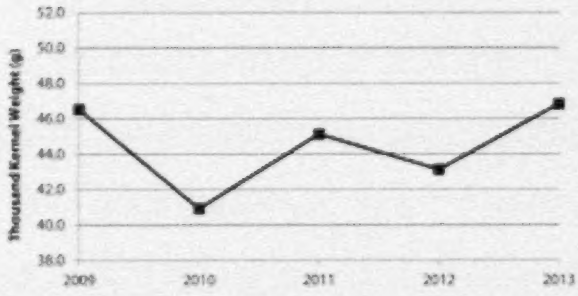



**Figure 4. Comparison of average levels of extract by variety in 2013**

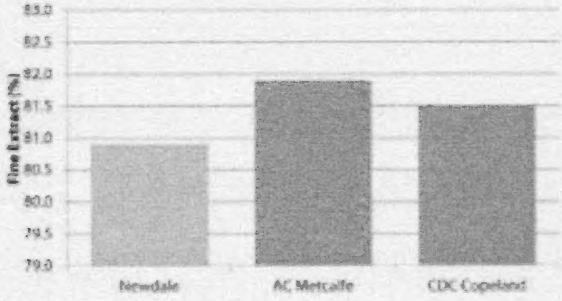
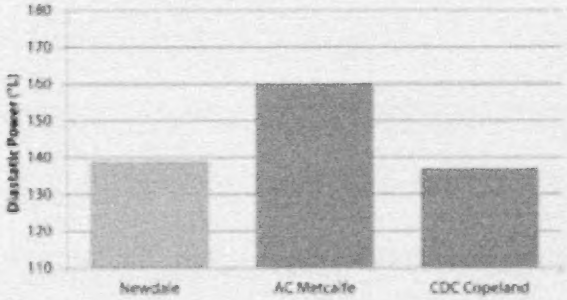



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**



## Table 3.8 Harvest survey results for 2013 composite samples of Newdale

| Origin of selected samples | Alberta | | All Prairie Provinces | | |
|---|---|---|---|---|---|
| Crop year | **2013** | 2012 | **2013** | 2012 | 5-year avg. |
| Thousands of tonnes[2] | **37** | 11 | **37** | 17 | 15 |
| **Barley** | | | | | |
| Physical characteristics | | | | | |
| Test Weight, kg/hL | **66.4** | 64.6 | **66.4** | 63.8 | 65.2 |
| 1000 kernel weight, g | **46.8** | 43.8 | **46.8** | 43.1 | 44.5 |
| Heavy grade, over 6/64" sieve, % | **93.2** | 88.7 | **93.2** | 87.7 | 91.0 |
| Intermed grade, over 5/64"sieve, % | **5.4** | 9.0 | **5.4** | 9.3 | 6.8 |
| Chemical analysis | | | | | |
| Moisture, %[3] | **11.5** | 13.7 | **11.5** | 13.4 | 12.7 |
| Protein, % | **11.7** | 12.6 | **11.7** | 12.6 | 11.9 |
| Germination, 4 ml (3 day), % | **99** | 99 | **99** | 98 | 99 |
| Germination, 8 ml (3 day), % | **91** | 91 | **91** | 85 | 90 |
| **Malt** | | | | | |
| Physical characteristics | | | | | |
| Yield, % | **89.8** | 91.6 | **89.8** | 91.6 | 92.5 |
| Steep-out moisture, % | **45.0** | 45.6 | **45.0** | 45.8 | 46.2 |
| Friability, % | **83.0** | 75.5 | **83.0** | 77.1 | 79.2 |
| Chemical analysis | | | | | |
| Moisture, % | **4.9** | 5.2 | **4.9** | 5.2 | 5.0 |
| **Wort** | | | | | |
| Fine grind extract, % | **80.9** | 78.6 | **80.9** | 78.8 | 79.6 |
| Coarse grind extract, % | **80.2** | 78.5 | **80.2** | 78.5 | 79.1 |
| F/C difference, % | **0.6** | 0.1 | **0.6** | 0.3 | 0.5 |
| ß-Glucan, ppm | **43** | 41 | **43** | 43 | 56 |
| Viscosity, cps | **1.42** | 1.39 | **1.42** | 1.39 | 1.40 |
| Soluble protein, % | **4.71** | 4.68 | **4.71** | 4.74 | 4.65 |
| Ratio S/T, % | **40.5** | 37.4 | **40.5** | 37.7 | 38.9 |
| FAN, mg/L | **185** | 178 | **185** | 181 | 169.8 |
| Colour, ASBC units | **1.87** | 1.86 | **1.87** | 1.98 | 1.87 |
| Diastatic power, °L | **139** | 155 | **139** | 154 | 142 |
| α-amylase, D.U. | **67.6** | 61.3 | **67.6** | 60.9 | 60.74 |

[1] Weighted average values
[2] Does not necessarily represent amounts commercially selected
[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# Bentley

Significant quantities of Bentley barley were grown and selected in 2013 to warrant inclusion in this report for the first time. With high yields and good disease resistance, Bentley is an attractive choice for producers. Bentley's consistently larger kernels have the potential to deliver high levels of extract.

**Figure 1. Percentage of the total malting barley acres in western Canada seeded to Bentley in 2012 and 2013**

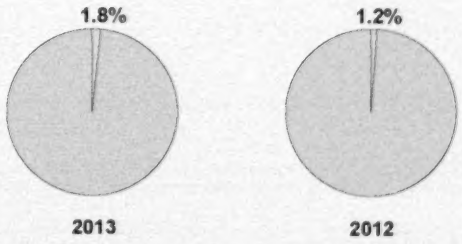



**Figure 2. Average protein content in selected for malting from 2009-2013**

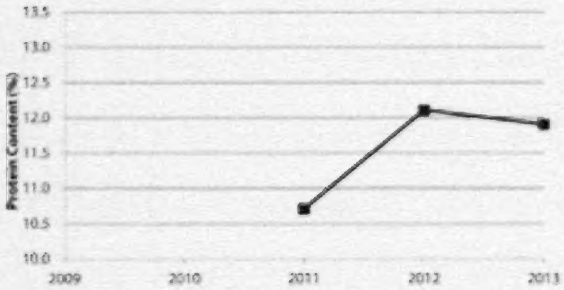



**Figure 3. Average kernel weight of Bentley selected for malting from 2009-2013**

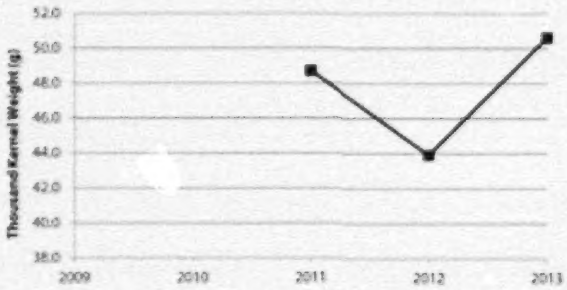



**Figure 4. Comparison of average levels of extract by variety in 2013**

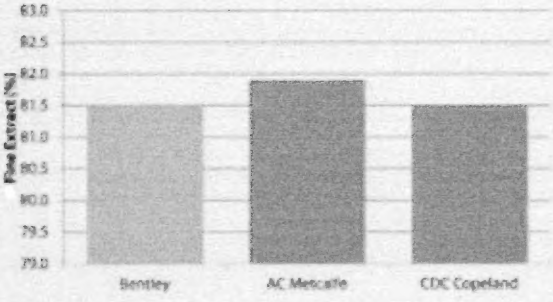



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**

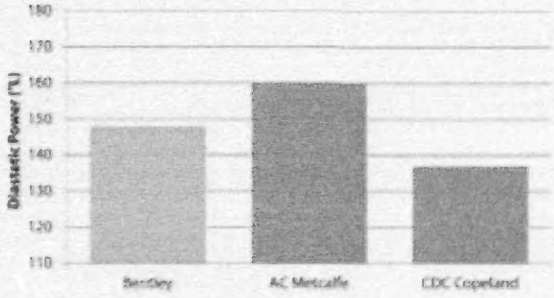


**Table 3.9 Harvest survey results for 2013 composite samples of Bentley**

| Origin of selected samples | Alberta | |
|---|---|---|
| Crop year | **2013** | 2012 |
| Thousands of tonnes[2] | **9** | 2 |
| **Barley** | | |
| Physical characteristics | | |
| Test Weight, kg/hL | **66.7** | 60.4 |
| 1000 kernel weight, g | **50.6** | 43.9 |
| Heavy grade, over 6/64" sieve, % | **95.8** | 88.4 |
| Intermed grade, over 5/64"sieve, % | **2.9** | 7.8 |
| Chemical analysis | | |
| Moisture, %[3] | **12.4** | 14 |
| Protein, % | **11.9** | 12.1 |
| Germination, 4 ml (3 day), % | **99** | 98 |
| Germination, 8 ml (3 day), % | **80** | 77 |
| **Malt** | | |
| Physical characteristics | | |
| Yield, % | **89.5** | 90.5 |
| Steep-out moisture, % | **45.3** | 46.6 |
| Friability, % | **78.3** | 75.5 |
| Chemical analysis | | |
| Moisture, % | **5.0** | 5.6 |
| **Wort** | | |
| Fine grind extract, % | **81.5** | 79.9 |
| Coarse grind extract, % | **80.8** | 79.6 |
| F/C difference, % | **0.7** | 0.3 |
| ß-Glucan, ppm | **41** | 44 |
| Viscosity, cps | **1.43** | 1.40 |
| Soluble protein, % | **5.06** | 5.00 |
| Ratio S/T, % | **42.5** | 42.1 |
| FAN, mg/L | **224** | 227 |
| Colour, ASBC units | **2.31** | 2.55 |
| Diastatic power, °L | **148** | 158 |
| α-amylase, D.U. | **61.0** | 63.1 |

[1] Weighted average values
[2] Does not necessarily represent amounts commercially selected
[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# CDC Kindersley

CDC Kindersley is a newer early maturing, high yielding variety descended from CDC Kendall. CDC Kindersley modifies easily, resulting in high friabilities and low levels of wort beta glucan. Its relatively high FAN and enzyme levels make it well suited for adjunct or high gravity brewing.

**Figure 1. Percentage of the total malting barley acres in Western Canada seeded to CDC Kindersley in 2012 and 2013**

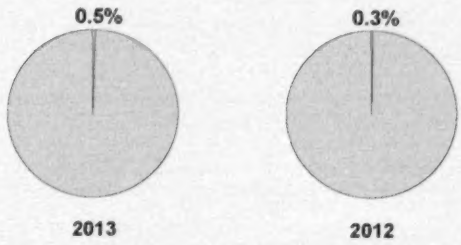



**Figure 2. Average protein content in CDC Kindersley selected for malting from 2012-2013**

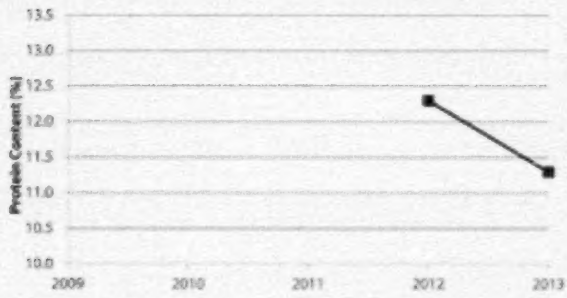



**Figure 3. Average kernel weight of CDC Kindersley selected for malting from 2012-2013**

**Figure 4. Comparison of average levels of extract by variety in 2013**

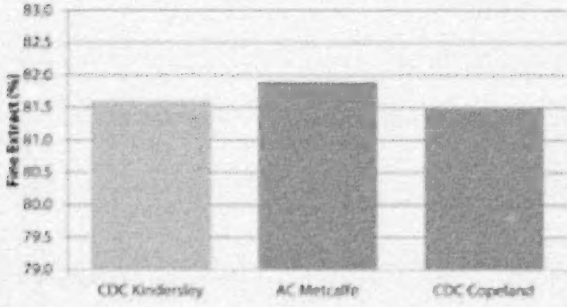
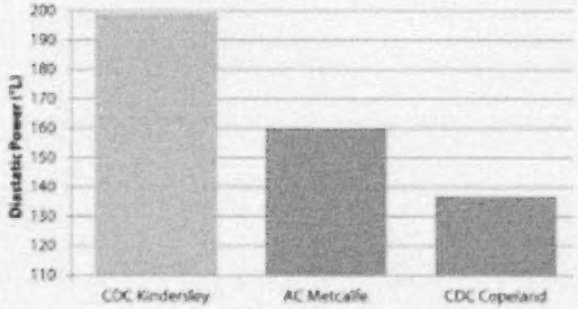



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**



## Table 3.10 Harvest survey results for 2013 composite samples of CDC Kindersley

| Origin of selected samples | Alberta | |
|---|---|---|
| Crop year | **2013** | 2012 |
| Thousands of tonnes[2] | **5** | 4 |
| **Barley** | | |
| Physical characteristics | | |
| Test Weight, kg/hL | **70.2** | 66.3 |
| 1000 kernel weight, g | **46.3** | 42.7 |
| Heavy grade, over 6/64" sieve, % | **94.5** | 89.3 |
| Intermed grade, over 5/64"sieve, % | **3.7** | 7.8 |
| Chemical analysis | | |
| Moisture, %[3] | **12.5** | 11.8 |
| Protein, % | **11.3** | 12.3 |
| Germination, 4 ml (3 day), % | **98** | 98 |
| Germination, 8 ml (3 day), % | **98** | 90 |
| **Malt** | | |
| Physical characteristics | | |
| Yield, % | **89.6** | 91.5 |
| Steep-out moisture, % | **44.8** | 45.8 |
| Friability, % | **81.2** | 70.4 |
| Chemical analysis | | |
| Moisture, % | **4.8** | 5.3 |
| **Wort** | | |
| Fine grind extract, % | **81.6** | 79.8 |
| Coarse grind extract, % | **81.3** | 79.4 |
| F/C difference, % | **0.4** | 0.5 |
| ß-Glucan, ppm | **28** | 44 |
| Viscosity, cps | **1.41** | 1.39 |
| Soluble protein, % | **5.10** | 5.51 |
| Ratio S/T, % | **45.2** | 44.0 |
| FAN, mg/L | **226** | 218 |
| Colour, ASBC units | **2.24** | 2.45 |
| Diastatic power, °L | **186** | 193 |
| α-amylase, D.U. | **74.3** | 62.3 |

[1] Weighted average values
[2] Does not necessarily represent amounts commercially selected
[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# Legacy

While acres planted to six-rowed malting barley are in decline, small amounts of Legacy barley continue to be grown and selected. Legacy's high enzyme package makes it ideal for high gravity or adjunct brewing.

**Figure 1. Percentage of the total malting barley acres in Western Canada seeded to Legacy in 2012 and 2013**

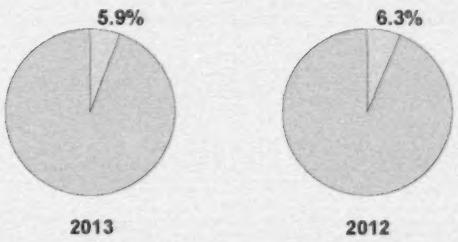



**Figure 2. Average protein content in Legacy selected for malting from 2009-2013**

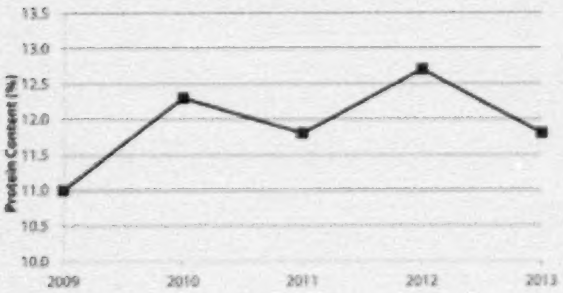



**Figure 3. Average kernel weight of Legacy selected for malting from 2009-2013**

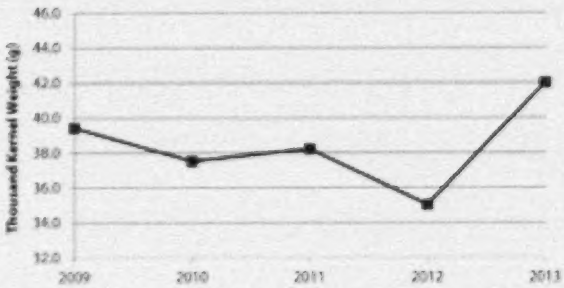



**Figure 4. Comparison of average levels of extract by variety in 2013**

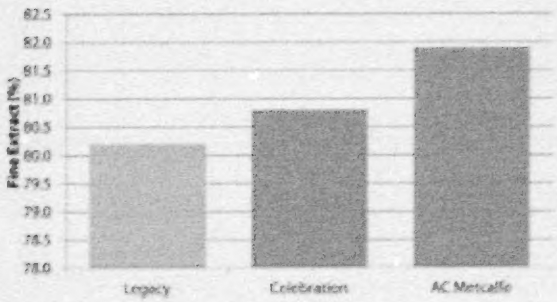
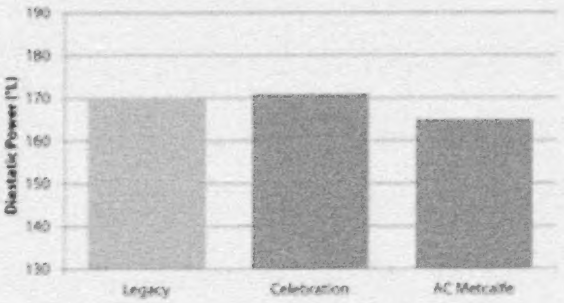



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**



## Table 3.11 Harvest survey results for 2013 composite samples of Legacy

| Origin of selected samples | Saskatchewan | | All Prairie Provinces | | |
|---|---|---|---|---|---|
| Crop year | **2013** | 2012 | **2013** | 2012 | 5-year avg. |
| Thousands of tonnes | **3** | 4 | **3** | 34 | 40 |
| **Barley** | | | | | |
| Physical characteristics | | | | | |
| Test Weight, kg/hL | **67.3** | 63.4 | **67.3** | 62.5 | 64.7 |
| 1000 kernel weight, g | **42** | 36.4 | **42.0** | 35.0 | 38.4 |
| Heavy grade, over 6/64" sieve, % | **95.9** | 88.9 | **95.9** | 87.9 | 92.5 |
| Intermed grade, over 5/64"sieve, % | **2.6** | 6.9 | **2.6** | 7.5 | 5.4 |
| Chemical analysis | | | | | |
| Moisture, %[3] | **12.5** | 10.6 | **12.5** | 10.0 | 11.5 |
| Protein, % | **11.8** | 12.6 | **11.8** | 12.7 | 11.9 |
| Germination, 4 ml (3 day), % | **96** | 98 | **96** | 94 | 97 |
| Germination, 8 ml (3 day), % | **91** | 47 | **91** | 64 | 79 |
| **Malt** | | | | | |
| Physical characteristics | | | | | |
| Yield, % | **91.6** | 90.8 | **91.6** | 91.8 | 92.9 |
| Steep-out moisture, % | **44.3** | 45.5 | **44.3** | 45.8 | 45.5 |
| Friability, % | **72.3** | 72.8 | **72.3** | 73.8 | 72.0 |
| Chemical analysis | | | | | |
| Moisture, % | **4.8** | 4.6 | **4.8** | 5.2 | 5.2 |
| **Wort** | | | | | |
| Fine grind extract, % | **80.2** | 78.6 | **80.2** | 78.9 | 79.2 |
| Coarse grind extract, % | **78.1** | 77.6 | **78.1** | 78.0 | 78.1 |
| F/C difference, % | **1.1** | 1.0 | **1.1** | 0.9 | 0.9 |
| ß-Glucan, ppm | **165** | 147 | **165** | 140 | 212 |
| Viscosity, cps | **1.48** | 1.42 | **1.48** | 1.40 | 1.45 |
| Soluble protein, % | **4.68** | 6.50 | **4.68** | 6.07 | 5.23 |
| Ratio S/T, % | **39.7** | 50.8 | **39.7** | 47.1 | 43.7 |
| FAN, mg/L | **213** | 274 | **213** | 267 | 221 |
| Colour, ASBC units | **2.62** | 3.44 | **2.62** | 2.74 | 2.33 |
| Diastatic power, °L | **170** | 183 | **170** | 198 | 182 |
| α-amylase, D.U. | **55.3** | 62.0 | **55.3** | 64.9 | 61.1 |

[1] Weighted average values
[2] Does not necessarily represent amounts commercially selected
[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# Celebration

Celebration is a newer six-rowed variety developed by Busch Agricultural Resources Inc. It has the potential for excellent malting quality, with higher extracts and balanced modification. Its malt quality profile is consistent with North American adjunct brewing requirements.

**Figure 1. Percentage of the total malting barley acres in western Canada seeded to Celebration in 2012 and 2013**

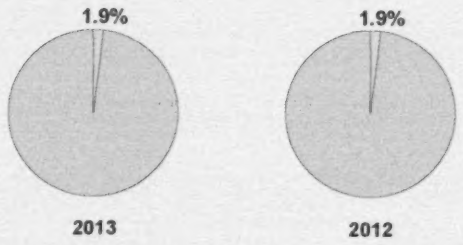



**Figure 2. Average protein content in Celebration selected for malting from 2009-2013**

**Figure 3. Average kernel weight of Celebration selected for malting from 2009-2013**

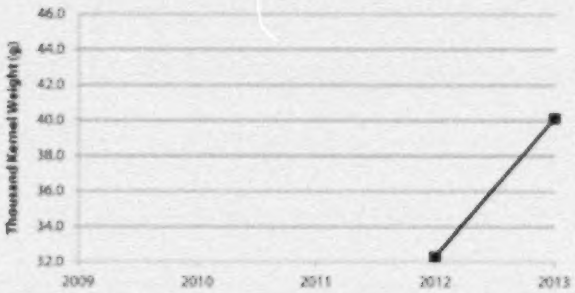



**Figure 4. Comparison of average levels of extract by variety in 2013**

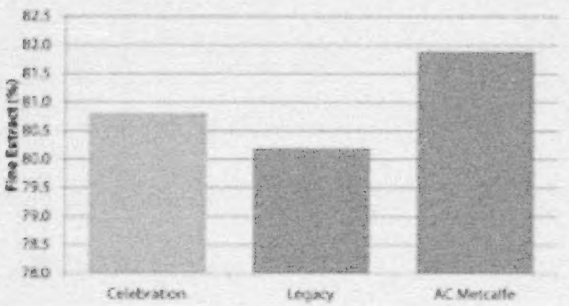
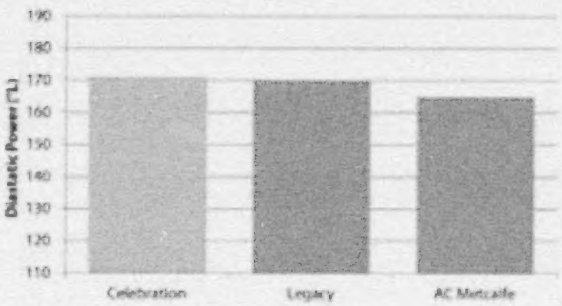



**Figure 5. Comparison of average levels of diastatic power by variety in 2013**



## Table 3.12 Harvest survey results for 2013 composite samples of Celebration

| Origin of selected samples | Manitoba | |
|---|---|---|
| Crop year | **2013** | 2012 |
| Thousands of tonnes[2] | **5** | 4 |
| **Barley** | | |
| Physical characteristics | | |
| Test Weight, kg/hL | **64.2** | 61.5 |
| 1000 kernel weight, g | **40.1** | 32.3 |
| Heavy grade, over 6/64" sieve, % | **96.2** | 85.4 |
| Intermed grade, over 5/64"sieve, % | **2.4** | 10.1 |
| Chemical analysis | | |
| Moisture, %[3] | **13.7** | 14.1 |
| Protein, % | **11.9** | 13.4 |
| Germination, 4 ml (3 day), % | **99** | 93 |
| Germination, 8 ml (3 day), % | **78** | 82 |
| **Malt** | | |
| Physical characteristics | | |
| Yield, % | - | 94.0 |
| Steep-out moisture, % | - | 47.9 |
| Friability, % | **84.0** | 85.7 |
| Chemical analysis | | |
| Moisture, % | **5.4** | 4.4 |
| **Wort** | | |
| Fine grind extract, % | **80.8** | 77.7 |
| Coarse grind extract, % | **80.1** | 76.9 |
| F/C difference, % | **0.7** | 0.8 |
| ß-Glucan, ppm | **94** | 91 |
| Viscosity, cps | **1.46** | 1.42 |
| Soluble protein, % | **4.68** | 5.61 |
| Ratio S/T, % | **39.3** | 42.7 |
| FAN, mg/L | **202** | 202 |
| Colour, ASBC units | **1.85** | 1.79 |
| Diastatic power, °L | **193** | 169 |
| α-amylase, D.U. | **57.8** | 55.5 |

[1] Weighted average values
[2] Does not necessarily represent amounts commercially selected
[3] Moisture not representative of new crop moisture levels as samples were not collected or stored in moisture-proof containers

# Appendix I - Methods

This section describes methods used at the Grain Research Laboratory. Unless otherwise specified, analytical results for barley and malt are reported on a dry weight basis.

**α-amylase activity**

α-Amylase activity is determined using ASBC method MALT 7B automated to run on a Skalar segmented flow analyser, using ASBC dextrinized starch as the substrate, and calibrated with standards that have been determined by method ASBC Malt 7A.

**Assortment**

All samples are passed through a Carter Dockage Tester equipped with a No. 6 riddle to remove foreign material and two slotted sieves to sort the barley. Heavy Grade barley is the material retained on a 6/64" (2.38 mm) x 3/4" slotted sieve. Intermediate Grade is barley that passes through the 6/64" x 3/4" sieve but is retained on a 5/64" (1.98 mm) x 3/4" slotted sieve.

**β-Glucan content**

B-Glucan content is determined in malt extract by Skalar segmented flow analysis using Calcofluor staining of soluble, high molecular weight ß-glucan (ASBC Wort-18B).

**Diastatic power**

Diastatic power is determined on a Skalar segemented flow analyzer, using an automated neocuproin assay for reducing sugars, which is calibrated using malt standards analysed using the official ferricyanide reducing sugar method, (ASBC Malt 6A).

**Fine-grind and coarse-grind extracts**

Extracts are prepared using an Industrial Equipment Corporation (IEC) mash bath and the Congress mashing procedure from 45°C to 70°C. Specific gravities are determined at 20°C with an Anton Paar DMA 5000M digital density meter (ASBC Malt-4).

**Free Amino Nitrogen (FAN)**

Free amino nitrogen is determined on the fine extract according to the official ASBC method Wort-12, automated to run on a Skalar segmented flow analyzer.

**Germination energy**

Germination energy is determined by placing 100 kernels of barley on two layers of Whatman #1 filter paper, in a 9.0 cm diameter petri dish, and adding 4.0 ml of purified water. Samples are controlled at 20 degrees Celcius and 90% relative humidity in a germination chamber. Germinated kernels are removed after 24 and 48 hours and a final count is made at 72 hours (ASBC Barley 3C).

**Kolbach index (ratio S/T)**

Kolbach index is calculated from the formula, (% Soluble protein/% Malt protein) x 100.

**Micromalting**

Malts are prepared using an Automatic Phoenix Micromalting System designed to handle twenty-four 500 g samples of barley per batch.

**Malt mills**

Fine-grind malt is prepared with a Buhler-Miag disc mill set to fine-grind. Coarse-grind malt is prepared with the same mill set to coarse-grind. The settings for fine- and coarse-grinds are calibrated quarterly, based on the screening of a ground ASBC standard check malt (ASBC Malt-4).

**Moisture content of barley**

Moisture content of barley is predicted using NIR equipment that has been calibrated by the standard ASBC method (ASBC Barley 5C).

**Moisture content of malt**

Moisture content of malt is determined on a ground sample by oven drying at 104°C for 3 hours (ASBC Malt-3).

**Protein content (N x 6.25)**

Protein content is predicted on dockage-free barley using NIR equipment that has been calibrated by Combustion Nitrogen Analysis (CNA). CNA is determined on a LECO Model FP-428 CNA analyser calibrated by EDTA. Samples are ground on a UDY Cyclone Sample Mill fitted with a 1.0-mm screen. A 200-mg sample is analysed as received (it is not dried prior to analysis). A moisture analysis is also performed and results are reported on a dry matter basis (ASBC Barley 7C).

**Rapid Viscometric Analysis**

The degree of pre-germination in barley was determined as described by Izydorczyk (2005); see the CGC website at http://www.grainscanada.gc.ca/research-recherche/izydorczyk/rva/rva-eng.htm. Samples were analyzed using the RVA-4 (Newport Scientific) and the Stirring Number Program. Final viscosity values were presented in Rapid Visco Units (RVU).

**Viscosity**

Viscosity is measured on fine grind Congress wort using an Anton Paar Lovis 2000 automated rolling ball viscometer (ASBC Wort-13B).

**Water sensitivity**

Water sensitivity is determined exactly as described for germination energy, except that 8.0 ml of purified water is added to each petri dish (ASBC 3C, IOB and EBC procedure). The water sensitivity value is the numerical difference between the 4ml and 8ml tests.

**Weight per thousand kernels**

A 500 gram sample of dockage-free barley is divided several times in a mechanical divider to obtain one representative 40g sub-sample. All foreign material and broken kernels are removed from one 40 gram portion and the net weight determined. The number of kernels is then counted with a mechanical counter and thousand kernel weight is calculated (as is basis) (Institute of Brewing's Recommended Methods of Analysis, Barley 1.3 (1997)).

**Wort-soluble protein**

Wort-soluble protein is determined spectrophotometrically using ASBC method Wort-17.

# Acknowledgments

The Grain Research Laboratory is grateful for the contributions of:

- Domestic grain handling companies and malting companies for providing composite samples of varietal selections of malting barley, especially to Mr. Fang So, Canada Malting Co. Ltd. (Calgary), Ms. Brenda Carter, Cargill Inc. (Winnipeg), Mr. Steve Hanson, Malteurop (Wininpeg), Mr. Spish Wisniewski of Parrish and Heimbecker Ltd. (Winnipeg), Mr. Kevin Sich, Rahr Malting Ltd, (Alix), Mr Owen Clune and Mr. Travis Philipchuk, Richardson International (Winnipeg), and Mr.Ian Armour, Viterra Inc. (Regina).
- Agriculture and Agri-Food Canada's National Agroclimate Information Services Unit for the weather and climatic data.
- Statistics Canada, for their publication on seeding and production figures.
- Shawn Parsons for barley analysis and micromalting, Debby Shaluk for complete malt analysis and Evan Nagasaka for technical assistance.
- Sharon Bazin and Tricia McMillan for RVA analysis
- The staff of the Multimedia Section of the Corporate Services Division of the CGC for their assistance with assembling this publication.